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Trimming as a Problem-Solving Tool

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Contents

1 Introduction

Classic creative methods such as trial and error or brainstorming quickly reach their limits when it comes to solving complex inventive problems. This is because they rarely lead to innovative, unconventional solutions which are nevertheless effective and efficient [11]. Therefore, to solve complex problems, we must turn to modern creative methods that enable us to think "outside the box".

One of these modern problem-solving methods is Trimming as a part of TRIZ, the theory of inventive problem solving. With Trimming, we try to simplify any system (e.g. technical, but also organisations or processes) in such a way that elements of the system can be omitted while maintaining the same or optimized functionality [6]. What prerequisites we need for this and how we can apply trimming is the focus of this work.

To this end, we will first look at TRIZ in *chapter 2* before defining Trimming in more detail in *chapter 3*. In *chapter 4* we clarify the prerequisites of Trimming and then in *chapter 5* we look at the process and rules of Trimming. The paper ends with a short conclusion in *chapter 6*. *Chapter 5* in particular is based mainly on the work of Darell Mann [6], as he provides a very clear tool for applying Trimming.

2 Placing: TRIZ

2.1 Classic and Modern Methods of Creativity

If one wants to solve a problem during inventive activity, this always requires some kind of creative approach. Before we define and examine TRIZ as a method of systematic problem solving in more detail, we will first look at the differences between classical and modern, contradiction-oriented creative methods [11].

Classical creative methods are characterised by a mostly hardly or not at all systematic approach to problem solving. Trial and Error are common here, i.e. finding solutions by simply trying things out without much preliminary consideration. On the one hand, approaches to solutions obtained in this way are very uncertain, since the suitability of their results is unclear due to the lack of preliminary considerations. This makes problem solving inefficient. In addition, hardly any innovative ideas are generated here - the first solution is rarely the best. Rather, thinking is done in conventional ways, which reduces the probability of actually solving the problem. This is because ideas that arise from conventional thinking usually move in the direction of the inertia vector, i.e. a kind of path of least resistance. Especially with Trial and Error, costs and benefits are out of proportion. But also other classic creative methods such as brainstorming or bionics rarely lead to an optimal result.

The complexity of problem-solving processes can therefore not be covered by classic creative methods. As a consequence, modern, contradiction-oriented problem-solving approaches have developed from the classic creative methods. In contrast to classical methods, they require divergent thinking, i.e. the systematic development of new, creative solution proposals off the beaten track. Modern creative methods can identify the (presumably) best solution through evaluation procedures before it has to be tested in practice.

TRIZ is an example for such modern creative methods of problem solving. What distinguishes it is part of the following section.

2.2 TRIZ: Definition, Main Aspects and Goals

TRIZ, Russian "Teorija Reshenija Izobretatjelskich Zadacz", i.e. "Theory for Solving Inventive Tasks" [1],[2],[11], was developed by the Russian engineer Genrikh Saulovich Altshuller for other engineers as part of his complex invention theor. Despite its technical origins, Altshuller intended TRIZ to be a cross-industry theory from the outset [1]. Not surprisingly, it has also been applied in non-technical fields, especially in recent decades [11].

As a theory of modern creative methods, TRIZ provides thought-provoking impulses and solution patterns to arrive (more) systematically at a (probably) functioning, innovative problem solution when inventing [8],[11]. The theory consists of over 30 different solution principles that have been expanded over time [11]. As a method of creative but systematic problem solving with the aim of discovering the undiscovered and thinking beyond what was previously thought, TRIZ cannot be applied in a template-like manner and the same sequence over and over again. The method provides a toolbox - how the tools are

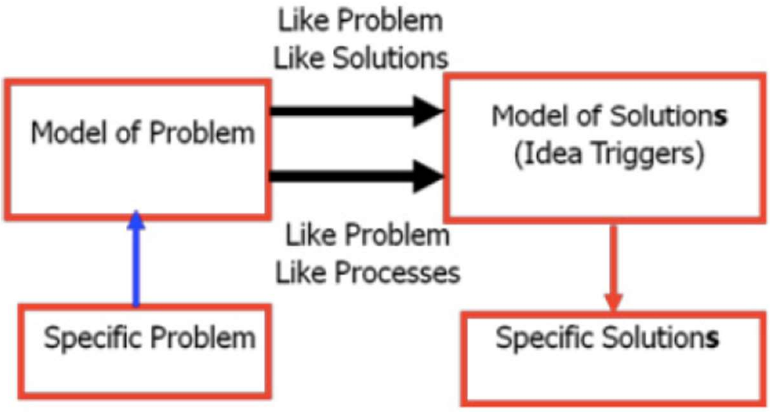


Figure 1: TRIZ Model of Problem Solving [10]

used must be decided on a problem-specific basis.

However, TRIZ follows a fundamental pattern that we can use as a guide in problem solving. *Figure 1* shows the fundamental principles of this problem solving tool [10]. At the bottom left we see a specific problem that needs to be solved. This problem is abstracted using various TRIZ problem analysis tools. This results in a kind of model of the problem, which is transformed into a model of problem solution. Similar problems can either be processed by means of similar solutions due to similar characteristics, or similar problems are solved by similar processes. Various concrete approaches to solving the problem then result from the model of problem solution. With TRIZ, we do not directly develop specific solutions for specific problems, but abstract the problem and its possible solutions in order to arrive at concrete solutions.

According to Souchkov [10], TRIZ focuses on **three main aspects**. The first consists of **solving contradictions**, which usually exist between two opposing elements in a system. These contradictions arise from conflicting goals the system is designed to achieve. They can be technical (achieving two different states for one element) or physical (improvement of one element leads to deterioration of another element within the system).

The second aspect is **ideality**. It results from the relationship between the perceived value of a system and the actual expenditure that must be made to produce that value. The general goal of TRIZ is always an Ideal End Result (IER) [1],[11]. The IER is achieved when a system (i.e. a machine, a procedure, a process, etc.) functions almost by itself. This ideal can hardly be achieved in reality, but it is important to get as close to it as possible [11].

Last but not least, TRIZ can be used to forecast trends in system development. Such a prognosis is possible because TRIZ makes the nature and constitutive principles of (technical) systems known.

3 Trimming as a TRIZ Problem-Solving Tool

Trimming is one of many ways to solve inventive problems using TRIZ. The problem-solving tool Trimming attempts to simplify a system in such a way that elements of the system can be omitted while maintaining the same or optimised functionality (*Figure 2*). The tool follows the Trimming trend: The trend describes how systems eventually develop in such a way that they contain fewer and fewer elements with at least the same functionality [6]. In this context, we understand a *system* to be a delimited set of elements whose interaction constructs a new, unified whole [5],[7]. According to Shchedrovitsky's systemic approach, systems are thus more than the mere composition of individual elements. We can define *elements* fundamentally as an entities which fulfill a function wihtin the system (e.g. physical components such as parts, people or departments in organisations, but also process steps).

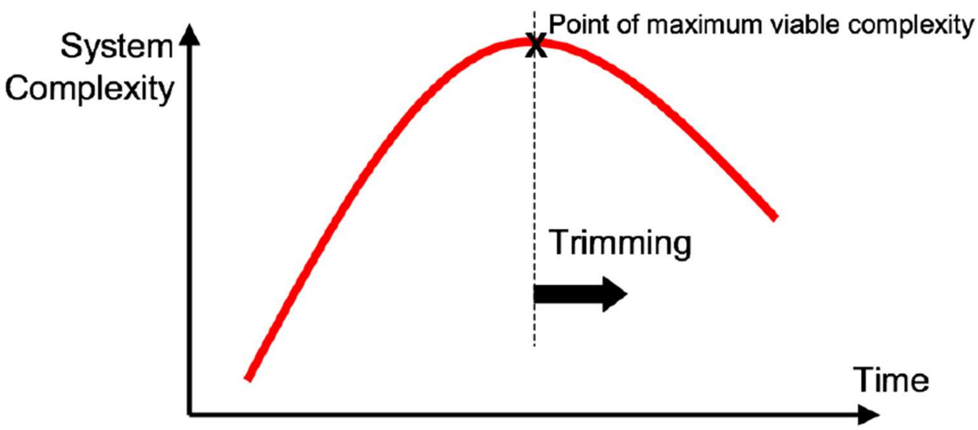


Figure 2: Trimming functional logic [6]

Basically, a distinction can be made between Device Trimming, Process Trimming and Organisational Trimming [9]. **Device Trimming** concerns elements of a physical product (e.g. controlling a navigation device and music in a car with a single controller instead of many individual buttons). With **Process Trimming**, certain elements, i.e. processes, are trimmed within a process (e.g. online applications to public authorities instead of submitting them by post in printed form). **Organisational Trimming** involves the omission of certain elements within organisations (e.g. merging or omitting departments).

Thus, when we apply Trimming, we solve a problem not by adding or replacing elements in a system, but by systematically reducing certain elements according to a certain scheme [9]. Before we look at this scheme in more detail, however, we need to clarify the prerequisites for Trimming.

4 Prerequisites for Trimming

4.1 Function and Attribute Analysis (FAA)

Function and Attribute Analysis (FFA) according to Darell Mann [6] precedes Trimming and is used for problem definition and abstraction similar to the TRIZ model of problem solving which we looked at in *chapter 2* (see also *Figure 1*). FAA is also based on abstracting a concrete problem to a concrete solution. FAA is "one of the three essential elements of the problem definition process. It represents a systematic method through which it is possible to analyse the detailed workings of a system" [6]. Only when we know and define a system as well as possible, we are able to improve it by solving problems that arise in it. The goal is to create a model of the system which is as accurate as possible and shows all it's elements as well as their functions and relationships as thoroughly and completely as possible [6]. We must always bear in mind that such a model is often less complex than the real system. Moreover, an FAA should not only be as exhaustive as possible, but also validated by more than one person [6].

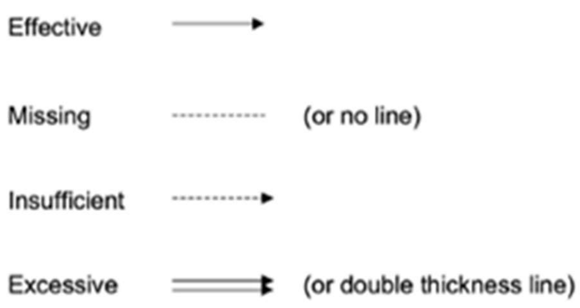
An FAA is applicable to all types of systems and proceeds in three successive steps [6], the order of which we must necessarily follow. In the first step, we define the **elements of the system**. In the second step, we define **useful relationships** between the elements by examining all pairs of elements for them. For some pairs of elements we will find that they have no relations to each other. But this too helps us to get an overview of what is happening wihtin the system, or at least what we think is happening in it.

Thirdly, we identify **negative relationships** between the elements in the system. We distinguish between 4 categories [6]:

- Harmful relationships: This refers to unwanted processes or occurrences within the system.
- Insufficient relationships: These are basically positive relationships, but they provide less benefit than desired.
- Excessive relationships: These relationships are also basically positive, but yield more benefits than desired.
- Missing relationships: These are positive relationships that we would like to have, but which are not currently present. They are the most difficult to detect.

The different types of relationships between elements are represented in the FAA by arrows (*Figure 3*, left side).

The FAA also identifies the Main Useful Function (MUF) of the system. In the example in *Figure 3* on the right side it can be seen that the MUF in within a shipping system is the delivery from supplier to customer. Identifying the MUF



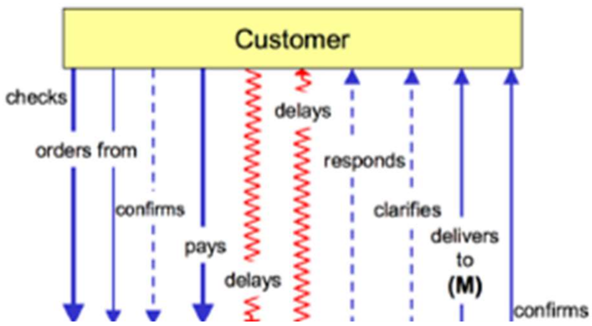


Figure 3: Left Side: FAA Relationship Labelling Conventions, right side: Example for FAA and MUF [6]

is important for Trimming because it allows us to identify functions without which a system would be obsolete or no longer viable.

With FAA, not only relationships between elements within the system, but also intangible elements (e.g. experience, knowledge, skills, emotions, etc.) and time elements are identified and classified positively or negatively like it is done with relationships. Furthermore, *attributes* can be relevant, which often determine the relationships between elements in the system: "Very often when elements have a functional relationship with other elements, it is one of these attributes that is affected rather than the element itself" [6]. Attributes for physical objects are e.g. size, weight or volume, for persons or groups of persons they include e.g. skills, creativity or determination [6].

4.2 Viable System Tests

Within a dynamic environment, a viable system is "capable of independent existence" [3] and can continuously develop and adapt to new (environmental) conditions through growth and learning processes. In his Viable System Model (VSM), Beer [3],[4] defines **five levels** that are necessary and sufficient **for the viability of a system**. They are universal and constitutive for every system. If we try to trim one of these levels, we basically have to find a substitute for them, since the system is not viable without them [6].

The five levels for the viability of a system are **implementation, co-coordination, intelligence, control and policiy** [6]. **Implementation** describes value-adding activities, i.e. parts of the system that are responsible for carrying out its main activities. These system parts can be subdivided into subsystems, which in turn are considered as a viable system.

Co-coordination means the coordination of these value-creating systems. The individual elements or subsystems and the system must communicate with each other and should do so as autonomously as possible so that they also function as autonomously as possible.

Intelligence is the reciprocal link between the primary activity of the system and its environment. Through prior analysis, the system can thus also adapt to future, changing environmental influences.

Control, i.e. structures and controls for systems, is defined as the reciprocal communication between subunit and meta-level, i.e. between subsystems and elements and the system as a whole.

Policy, the top decision-making unit of the system, has a directive function and ensures the closure of the system as a whole by setting general direction, values and purpose of the system.

4.3 Management of Functionally Coupled Elements

The complexity of a system increases over time. Complexity does not (necessarily) correspond to the number of elements in the system. A system is also complex if it contains few elements with many functions [6]. The increasing complexity of a system sooner or later leads to ist need for being optimised, e.g. by Trimming. There is an optimal complexity level in every development phase of a system. It is defined by the minimum level of complexity required to give the system autopoetic properties - i.e. properties through which a system can survive and

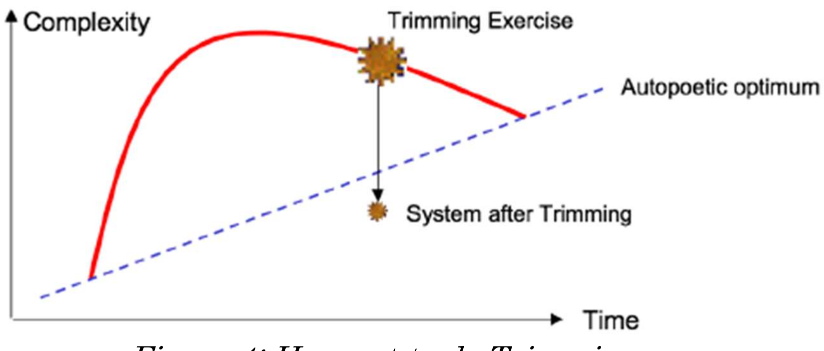


Figure 4: How not to do Trimming

reproduce in a sustainable way [6]. Trimming must never jeopardise the autopoetic capability level of a system. This means that before trimming, we must think carefully about which elements we want to trim and whether they are constitutive of the system's viability (e.g. through FAA). Trimming elements which make up a viable system might cause huge inconveniences (*Figure 4*). In the worst case, the system is no longer functional and we have caused harm rather than benefit by Trimming.

5 Trimming Procedure and Rules

5.1 Trimming Tool according to Mann

The following explanations are mainly based on the Trimming tool by Darell Mann [6].

A prerequisite for Trimming is, as explained in *chapter 4.1*, a completed FAA - because before we can trim, we need to know exactly the system within we want to trim. In this way, we avoid trimming useful elements or elements that are vital for the system, or we avoid trimming the wrong elements.

We start Trimming with the **Trimming provocation** "Why don't we eliminate this element?" We then work through a series of top-down questions, which can be seen in *Figure 5*. It is important that we follow the order of the list. The questions are applicable to both physical elements and processes. For processes, they can be rephrased accordingly.

Do we need the useful function(s) performed by this element?

Can one of the other elements in the system perform the useful function(s) instead?

Could we modify one of the other elements to perform the useful function(s)?

Is there an element or resource around the system that can perform the function(s)?

Is there an element or resource around the system that could be modified to perform the function?

Can we perform the function(s) by combining other elements and resources?

Figure 5: Trimming Questions

If we can trim an element on the basis of the first question, this usually leads to a more ideal solution than a solution resulting from the second question. This solution is then again more ideal than a solution based on the third question and so on. The more questions in the list are answered with "yes", the more difficult and complex the trimming process becomes. But this also means: If we determine an element does not fulfil a useful function - so we answer the first question with "no" - the element in question can be trimmed directly.

First and foremost, we therefore deal with whether the element in question has a useful function at all and whether this function is actually required. If this is not the case and we trim the element, we have to make sure that the element does not fulfil any other useful tasks (defined in the FAA model) within the system and that the Trimming does not impair the functionality of the system in future scenarios. An example: In the case of a computer mouse decorated with glitter stones, the glitter stones can be trimmed. Their useful function is at most to enhance the mouses appearance, but they are not necessary for its functionality. The stones thus do not fulfil any other useful functions for it and do not impair its functionality in future scenarios.

However, if we have answered the first question in the affirmative, we implicitly derive from this the assumption that we want or need the function of the element. This is followed by the question of whether another element in the system can take over the function instead. To find this out, we start with the elements that are closest to the element to be trimmed and work from there to the elements that are furthest away from it. For example, if we had a hypothetical car with two engines and our concern is that the car should continue to drive, we can trim one of the two engines. The one that remains directly takes over the function of the trimmed engine, i.e. powering the car.

The next question is whether we can change other elements in the system in such a way that they fulfil the useful function of the element to be trimmed. For example, if we want to do without a separate fingerprint sensor on the back of a smartphone, we can also integrate it into the unlock button. The useful function, i.e. unlocking the smartphone by fingerprint, is then retained and the separate sensor is no longer necessary.

Now we can ask ourselves whether there is an element or a resource in the environment of the system that might perform the useful function of the element to be trimmed. A resource is "[a]nything in or around a system that is not being used to is maximum potential" [6]. In the case of a car, for example, we could think about alternative fuels or drive systems. In this connection, we can also examine if there is a resource in the environment of the system which can be changed to fulfil the useful funktion of the element tob e trimmed

Finally, we ask ourselves whether the useful function of the element to be trimmed can be fulfilled by combining other elements or resources. In doing so, we can combine the possibilities we identified in the previous questions to fulfil the function of the element to be trimmed. However, this far down the list of questions, the probability of successful trimming is low and a lot of creativity is required.

5.2 Trimming Sequence according to Mann

Away from the Trimming tool, Mann [6] provides us with the Trimming Sequence, four useful priciples to facilitate the application of Trimming. However, they cannot tell us which elements should be trimmed in which order, but only provide rough food for thought.

The **first priciple** states elements in a system having the greatest number of undesirable functions (see also negative relations FAA) are prime candidates for Trimming. In the case of headphones, this could e.g. be their cables- Although they ensure that listening to music with headphones is possible at all, they also break very quickly, often get tangled or cause you to quickly get caught somewhere when moving. That's why they can be trimmed and e.g. be replaced with Bluetooth instead.

The **second priciple** states that elements with causing the highest costs within the system should be considered for Trimming before elements with lower costs. Here, elements with the highest value offer the greatest benefit in Trimming. In companies, for example, a large part of the costs are often caused by staff, so it often makes sense for companies to look at where staff could be axed.

According to the **third principle**, the highest elements in the functional hierarchy within a system should be prioritised in Trimming considerations. This is because if elements with the most important functions are trimmed successfully (i.e. while preserving autopoetic system properties), this offers the highest potential gain. The staff example could also be applied here.

Finally, the **fourth principle** states that elements with the lowest number of useful functions are prime candidates for Trimming. Here one might return to the example of the glitter stones on the computer mouse.

5.3 Additional Trimming-Rules

Sheu and Hou [9] list some further Trimming rules that can help us decide which elements we want to trim within a system or whether there are elements that we can trim at all. The starting point is that every element in the system is performing at least one useful function, otherwise it would not be part of the system. The element in question, let's call it element A (function carrier), carries a function which imapcts another element B (object of the function) within the system.

Trimming rule A now states that the function carrier can be trimmed if the object of the function is trimmed or is no longer present in the system for some reason. For example, if there were no more other road users (Object of the Function), we could trim the horn of a car (Function Carrier). This is because its function of warning other road users would then no longer be needed. Rule A is very powerful. If we apply it correctly, we are able of trimming two elements in a system at once.

Trimming rule X states that we can trim the Function Carrier if its function is deleted or not needed. This is roughly equivalent to question one from Mann's Trimming tool [6].

If the Object of the Function can perform the function of the Function Carrier itself, then the Function Carrier can be trimmed according to **Trimming Rule B**. If, for example, there were fully automatic cash registers (Object of the Function) in a supermarket which could correctly register all goods, the supermarket would no longer need any cashiers (Function Carriers); they could then be trimmed.

Trimming rule C can already be found in a similar form in Mann's Trimming tool [6]. It states that the Function Carrier can be trimmed if an element inside or outside the system can take over its the useful function.

With **Trimming rule D**, it is accepted that the function of the system may no longer be fully maintained by trimming the Function carrier. The benefit may nevertheless outweigh the disadvantage here if a corresponding new or niche market is found for the trimmed element.

Finally, in **Trimming rule E**, the Function Carrier is replaced by a new element in the system which was not previously present within the system or its environment and improves the functional performance of the system or reduces costs or damage.

6 Conclusion

The Trimming problem-solving tool attempts to simplify a system in such a way that elements of the system can be omitted while maintaining the same or optimised functionality. With trimming as a TRIZ problem-solving tool, we can manage inventive problems in such a creative, yet systematic and efficient way. However, ‚systematic' does not mean that we can simply apply the Trimming tool according to Mann [6] or the Timming rules named by Sheu and Hou [9] identically to every problem in a template-like manner. However, according to the TRIZ Model of Problem Solving, the basic principle is always the same: We abstract a concrete problem and its possible solutions and thus arrive at concrete possible solutions.

So with Trimming we get a basic tool and, depending on the problem, we have to think about how to make use of it; which elements of a system we absolutely have to keep and which we can remove, replace or merge in order to optimise the system as a whole. However, therein also lies a clear advantage of Trimming, because we can use it to solve problems from many different areas - not only technical ones.

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